Keith Shuttleworth & Associates Limited

STEAM QUALITY TEST KIT SQ1

Set Up And User Guide

Distributed by

Steam Quality Test Kit SQ1

User Manual Version 1.5 USA

Acknowledgments made to HTM2010 & EN285

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Keith Shuttleworth & Associates Ltd
Unit D5 Basepoint Business Centre
110 Butterfield
Luton LU2 8DL
Telephone +44 (0)1582 433723
Fax +44 (0)207 1173251
United Kingdom Email info@ ksapharma.com
Web www.ksapharma.com

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Introduction

Thank you for choosing the KSA Steam Quality Testing Kit SQ1. This kit was developed through extensive practical experience and has been designed to provide reliable and consistent results that conform to the requirements of EN285/ HTM 2010.

The non-condensable gas test has been designed to be more robust than the standard equipment and also less dependent upon the skill of the operator. It will be found that it will provide results that are more consistent than the EN285/HTM 2010 method.

The dryness test equipment is similar to that described in EN285/HTM 2010, but has been modified to make it more robust. If the calculation provided within and on the CD is used, results identical to EN285/HTM 2010 will be obtained.

The superheat test equipment is identical to that in EN285/HTM 2010.

Warning

Before conducting any tests the contents of this manual must be studied in depth and any associated hazards considered. It is stressed that the test methods are defined in EN285 and HTM 2010 and not by the authors of this manual, and that these documents are the primary references. Sterilizer plant rooms are potentially hazardous areas and the tests involve working on live steam. It is assumed by the authors of this manual that staff conducting steam quality testing will be trained and understand the potential dangers involved with respect to burning, due to contact with either steam or hot surfaces or any other related hazards.

Warranty

The SQ1 Steam Quality Test Kit is designed and manufactured to the highest standards, using top quality materials. A one year parts only warranty applies from the date of delivery to the customer. The warranty does not apply to abuse or misuse of the equipment, or its use outside of the operating parameters defined within this manual.

Additional Equipment Requirements

To enable you to complete the steam tests, additional equipment is required.

1. Two temperature sensors and indicator/recorder capable of measuring over a range of ambient water temperature to maximum steam supply temperature (Typical 0 – 150^{o} C). The sensor used for the superheat test should not exceed 4mm diameter.

2. 1 thermocouple entry gland for the steam supply pipe work.

3. A balance capable of measuring up to 2Kg with 0.1g accuracy.

4. 1 or two buckets or other water storage container. A permanent water supply may also be used.

5. A mains power source (optional).

6. A supply of cold water

Steam Test Points

In order to test the steam quality specific test points on the steam line are required.
Fig. 1 Illustrates the location of the three test points on the steam supply pipe and they are fitted between the steam distribution system and the sterilizer. It is expected that the pressure at this point would be 2-5BarA.

It is important the pitot tube entry point is level and parallel with the steam pipe as any deviation towards the edge of the pipe can influence the results detrimentally.

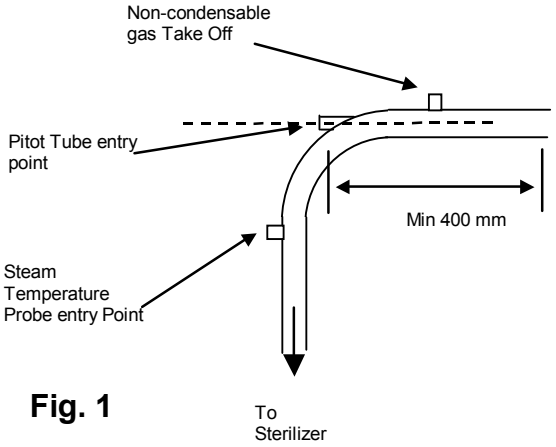

Fig. 1

Note All entry points are 1/4 NPT female sockets with full size holes drilled through the pipes.

Assembling the Steam Test Kit

NON-CONDENSABLE GAS KIT

1. Burette Bulb
2. Burette Cock
3. Burette
4. Burette Guide
5. Condense Collection Cylinder
6. 250 ml Measuring Cylinder
7. Steam Valve
8. Cooling Water Valve
9. Steam Condensing Unit
10. Cooling Water Inlet
11. Cooling Water Outlet
12. Steam inlet

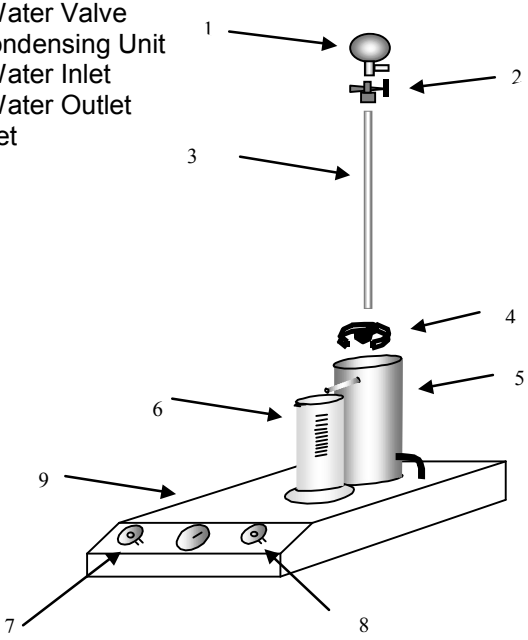

Fig 2

Rear View of Steam Condensing Unit

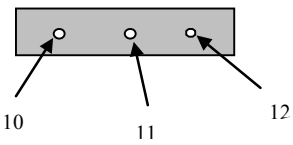

Fig 3

SUPERHEAT KIT

1. Superheat Expansion Tube
2. Pitot Tube
3. Insulation
4. Temperature probe entry gland

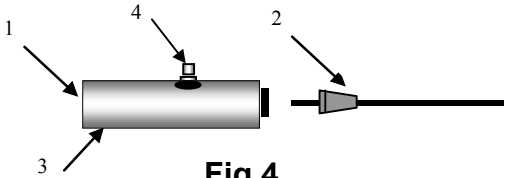

Fig 4

DRYNESS TEST KIT

1. Pitot Tube
2. Tubing
3. Tube Clamps
4. Rubber Bung and Tube Assembly
5. 1 Litre Flask

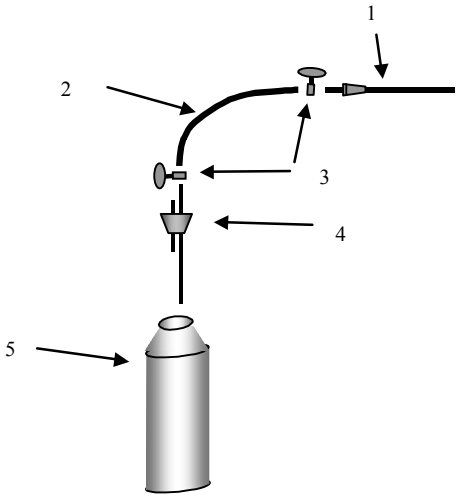

Fig 5

The Coolant Transfer Unit

To condense the steam in the non-condensable gas testing unit, a supply of cold water is needed. Due to the difficulty that is often found in finding an accessible supply of water in a sterilizer plant room, a coolant transfer unit has been included in this kit.

The unit is a 110 volt, 60 Hz, alternating current pump that needs to be totally submerged in water.

There are two methods of utilizing this pump unit.

1 The unit may be placed in the make up tank of the sterilizer or other convenient water reservoir.

2 Alternatively, place the pump unit in a bucket of water. There should be enough water in a standard bucket to enable testing to continue for approximately 10 -15 minutes before replacement of the water, with cold is required.

Do not place the pump in a make up tank that re-circulates its water, as the fluctuating temperatures could make obtaining a consistent condensate temperature hard to achieve and damage to the pump may occur.

In a tank that has silt or other debris present, it is recommended that the filter is fitted to the pump.

Note.Do not let the pump unit run dry as damage to the pump may occur.

Non-condensable Gas Test

SETTING UP

1. Assemble equipment together as illustrated in Fig. 2. Place on a level surface. Check that the Steam Valve on the test equipment is fully closed and that the Cooling Water Valve is fully open.
2. Connect the cooling water supply pipe to the pump at one end and the Cooling Water Inlet on the condensing unit at the other (Fig. 3). Connect another pipe from the Cooling Water Outlet to drain or a bucket. Place the pump unit in a suitable water source. If desired the pump unit may be omitted and the water feed connected to a more permanent source. Please note that the water from the Cooling Water Outlet may be very hot and care should be taken to ensure that it can run to drain unimpeded and without spillage.
3. Isolate the steam supply and after checking that no residual pressure is present, connect the 4mm copper steam supply tubing to the non-condensable gas take of point (Fig. 1) via a ¼" isolation valve. Take care, as the steam pipe may be hot and residual steam may be present. Connect the other end of the 4mm tube to the steam connection of condensing unit (see Fig. 3) and turn the steam supply back on. Carefully open the ¼" isolation valve a small amount. The copper steam pipe supplied will be hot. While it is insulated, this is to protect the user against casual contact. Even a short contact time will result in a burn, unless the necessary precautions have been taken

Warning. **Do not block or impede the flow of cooling water The cooling water outlet must be kept clear at all times.**

PERFORMING THE TEST

1. Before starting the test ensure the cooling water valve is fully open and the steam valve is closed.
2. Turn on the water supply by supplying power to the pump. After ensuring that the cooling water is leaving the outlet pipe, the main steam valve may be slowly opened. Live steam and boiling water could discharge from the condense collecting chamber if insufficient cooling water is available and present a hazard. In any event, precautions should be taken. Do not look into the collecting chamber and wear eye protection.

3. Slowly open the steam valve and by reducing or increasing the flow through the steam and water valves, obtain a flow of condense that will give a temperature of between 70^{o} C and 90^{o} C, as indicated on the dial temperature gauge.

4. Fill the condense collection chamber with water either by filling with water from an external source, or allowing condense to accumulate.

5. Open the burette cock and draw up condense into the burette with the rubber bulb provided, to get a water level near the top. Remember to isolate the burette from the rubber bulb by shutting the burette cock before testing commences.

6. Fill the condense collection chamber with more water, until it overflows.

7. Ensure that the sterilizer chamber is empty except the normal furniture etc. Select a porous load/equipment cycle and start a run.

8. When the steam supply to chamber first opens, ensure the measuring cylinder is empty, by emptying it.

9. Make a note of the water level in the burette.

10. Any non-condensable gases present in the steam being sampled will rise to the top of the burette. The overflow formed by the condensate and the water displaced by the gases, will collect in the measuring cylinder.

11. When the at least 100ml of condense has been collected in the measuring cylinder note the volume of gas collected in the burette (Vb) and the volume of water collected in the measuring cylinder (Vc).

12. Calculate the fraction of non-condensable gases as a percentage as follows:

    Percentage of non-condensable gas = 100 x (Vb/Vc)

A C C E P T A N C E C R I T E R I A

The test should be considered satisfactory if the level of non-condensable gases does not exceed 3.5%.

The test should be done three times in total to check consistency. If the results of the tests differ significantly, then the cause should be investigated before proceeding further.

Calculations are included on an enclosed CD.

The Superheat Test

SETTING UP

1. Assemble the apparatus as per Fig. 4.
2. Isolate the steam supply and after checking that no residual pressure is present, insert a temperature sensor entry gland into the fitting on the steam pipe. The steam pipe may be hot and precautions should be taken against both burning and the presence of residual steam. The temperature probe should be at the geometric center of the steam pipe. Insert the appropriate size pitot tube (see Table 1 below for the correct size) into the steam supply. Turn the steam supply back on, taking the necessary precautions against burning/scalding from the steam that will issue from the pitot tube.

Table 1	Steam Pressure (Bar)	Up to 3	Up to 4	Up to 7
	Pitot Hole Size (mm)	0.8	0.6	0.4

1. Insert a temperature sensor through the entry gland of the expansion tube and position it so the sensing point of the thermocouple element is in the geometric center of the expansion tube. Cover the expansion tube with the lagging. Push the expansion tube onto the pitot tube taking the necessary precautions. This will require the tester to be in close proximity to the steam issuing from the pitot tube and extreme care is required to avoid scalding and/or burning. Gloves, overalls and eye protection must be worn.

PERFORMING THE TEST

1. Ensure the sterilizer chamber is empty except for the usual chamber furniture. Select and start a porous load/equipment cycle.
2. From the measured temperatures, note the temperature in the steam service pipe (for use in the dryness test) and in the expansion tube (T_e) when the team supply to the chamber first opens.
3. Calculate the superheat in ^{o}C from the following equation.Superheat = $T_e - T_0$

   Where T_0 is the boiling point of water at local atmospheric pressure.

ACCEPTANCE CRITERIA

The test should be considered satisfactory if it the superheat measured in the expansion tube does not exceed 25° C and the temperature measured in the steam pipe did not differ by more than 3°C from that measured in the steam pipe during the steam quality. Dryness test Calculations are provided on an enclosed CD.

Dryness Test

SETTING UP

1. Assemble the apparatus as per Fig. 5.
2. Isolate the steam supply and after checking that no residual pressure is present, insert a temperature sensor entry gland into the fitting on the steam pipe. The steam pipe may be hot and precautions should be taken against both burning and the presence of residual steam. The temperature probe should be at the geometric center of the steam pipe. Insert the appropriate size pitot tube (see Table 1 below for the correct size) into the steam supply. Turn the steam supply back on, taking the necessary precautions against burning/scalding from the steam that will issue from the pitot tube.

Table 1	Steam Pressure (BarA)	Up to 3	Up to 4	Up to 7
	Pitot Hole Size (mm)	0.8	0.6	0.4

PERFORMING THE TEST

Important

Before performing the test ensure the pitot hole is not restricted as this will lead to false results. This is best done prior to fitment for safety reasons. A long heat up time for the flask reaching ~80oC is not normal. It should take no more than 5 minutes.

1. Weigh the whole assembly including pipe and clips and note the weight (M_1).
2. Remove the stopper and tube assembly and pour 650 +/- 50 ml of cold water (below 27^{o} C) into the flask. Replace the stopper and tube assembly, weigh the flask and record the mass (M_2).
3. Support the flask close to the pitot tube taking care to avoid the issuing steam. Ensure that the rubber tube and flask are protected from excess heat and draughts. Do not connect it to the pitot tube yet.
4. Introduce the second temperature sensor through the shorter of the two pipes into the water in the flask. Agitate the flask and note the temperature of the water in the flask (T_0).
5. Ensure the sterilizer is empty except for the usual chamber furniture. Select and start a porous load/equipment cycle.
6. When the steam supply valve to the chamber first opens, connect the rubber tube to the pitot tube. This will require the tester to be in close proximity to the steam issuing from the pitot tube and extreme care is required to avoid scalding and/or burning. Gloves, overalls and eye protection must be worn.

7. Observe/record the steam temperature for the duration of the test and on completion of the test calculate the average temperature (T_S).

8. When the temperature in the flask is approximately 80° C, disconnect the rubber tube from the stainless steel tube taking the same precautions as when fitting. Agitate the water in the flask to make sure it is thoroughly mixed. Note the temperature of the water (T_1).

9. Weigh the flask and stopper assembly including pipe and clips and note the mass (M_3).

10. Calculate the dryness value by using the following formula.

$$D = \frac{(T_1 - T_0)(4.18\,M_W + 0.23)}{L\,M_C} - \frac{4.18(T_S - T_1)}{L}$$

Where:
D = Dryness value
M_W = The initial mass of water in the flask is $M_2 - M_1$
M_C = The mass of condense collected is $M_3 - M_2$
T_0 = Initial temperature of the water in the flask (° C)
T_1 = Final temperature of the water and condense in the flask
T_S = Average temperature of the steam delivered to the flask
L = Latent heat of dry saturated steam at temperature T_S (KJ Kg^{-1}) - see Appendix 1 for latent heat tables.

If a computer-spread sheet is to be used then this formula can be used in H17, as in this example spread sheet.

=(((H9-H7)*(4.18*(H3-H1)+0.23))/(H13*(H5-H3)))-((4.18*(H11-H9))/H13)

A	B	C	D	E	F	G	H
1	Total weight of flask, pipes etc						0.8148
2							
3	Total weight of flask and 650ml of water						1.449
4							
5	Total weight of flask + condense						1.5368
6							
7	Initial temperature of water in flask						11.2
8							
9	Final temperature of water and condense						82.4
10							
11	Average temperature of steam delivered to sterilizer						155.5
12							
13	Latent heat of average temperature of steam delivered to sterilizer						2096.7
14							
15							
16							
17	Dryness value						0.969

Note. The formula has been modified for stainless steel flasks and dip tubes instead of glass, as detailed in HTM 2010.

ACCEPTANCE CRITERIA

The test should be considered satisfactory if the following requirements are met:

1. The dryness value is not less than 0.90 (if metal loads are processed, the dryness value should not be below 0.95).

2. Through out the operating cycle, the temperature measured in the steam service pipe is within 3°C of that measured during the superheat test.

Calculations are included on an enclosed CD.

Health and Safety

Care should always be taken when working on or near steam pipes due to the very high temperatures involved. Thermal gloves, overalls that cover arms and eye protection must be used.

While every effort has been made to provide protection from the extreme temperatures, care should be taken when testing with this equipment.

Do not plug or restrict the “Cooling Out” flow as this may pressurize the heat exchanger, which it has not been designed for.

Do not look into the condense collection cylinder while the steam valve is open, as hot condense and/or steam could be ejected.

The insulation surrounding the steam pipe is made from glass fibre and can cause irritation to the skin in some instances. It is therefore recommended that gloves or a good quality barrier cream be applied as a precaution before handling the material. The insulation is designed to prevent burns from transient contact with the pipe and is not designed to protect against prolonged contact.

The submersible pump is electrically powered and care must be taken to prevent hazards arising from the use of electricity in a potentially wet environment.

Care and maintenance

No special care is required for the steam test kit. However, the 4 mm copper tubing, will with bending, become work hardened, which will lead to difficulty in returning it to the tight radius required for storage. In this instance, it may be easily replaced.

Should difficulty be found in obtaining a replacement or any other components, please contact your local Distributor in the first instance or Keith Shuttleworth & Associates Ltd for replacements.

Equipment specifications: -

Non-condensable gas test kit	0-20% N/C per 100ml condensed steam
Dryness test	Full range
Superheat test	Full range
4mm steam supply tube	Max 10 BarG Steam
8mm Coolant supply tube	Max 3 BarG at 20^{o} C
Condensing unit (Steam side)	Max 5 BarG at 160^{o} C
Condensing unit (Water side)	Max 4 BarG at 20^{o} C
Pitot Tubes	Max 6 BarG at 165^{o} C

Appendix 1 Steam Tables

Pressure BarA	Temperature	Latent heat
2.0	120.42	2201.1
2.1	121.96	2197.0
2.2	123.46	2192.8
2.3	124.9	2188.7
2.4	126.8	2184.8
2.5	127.62	2181.0
2.6	128.89	2177.3
2.7	130.13	2173.7
2.8	131.37	2170.1
2.9	132.54	2166.7
3.0	133.69	2163.3
3.1	134.82	2160.1
3.2	135.88	2156.9
3.3	136.98	2153.7
3.4	138.01	2150.7
3.5	139.2	2147.6
3.6	140.0	2144.7
3.7	140.96	2141.9
3.8	141.92	2139.0
3.9	142.86	2136.1
4.0	143.75	2133.4
4.1	144.67	2130.7
4.2	145.46	2128.1
4.3	146.36	2125.5
4.4	147.20	2122.9
4.5	148.02	2120.3
4.6	148.84	2117.8
4.7	149.64	2115.3
4.8	150.44	2112.9
4.9	151.23	2110.5
5.0	151.96	2108.1
5.1	152.68	2105.7
5.2	153.40	2103.5
5.3	154.12	2101.2
5.4	154.48	2098.9
5.5	155.55	2096.7
5.6	156.24	2094.5
5.7	156.94	2092.3
5.8	157.62	2090.2
5.9	158.28	2088.1
6.0	158.92	2086.0
6.2	160.20	2081.8
6.4	161.45	2077.8
6.6	162.68	2073.8
6.8	163.86	2069.9
7.0	165.04	2066.0
7.5	167.83	2056.8
8.0	170.50	2047.7
8.5	173.02	2039.2
9.0	175.43	2030.9